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(54) FUEL CELL POWER GENERATOR SYSTEM WITH HIGH POLYMER
SOLID ELECTROLYTE

(57)Abstract:

PURPOSE: To provide a solid high-polymer electrolyte type fuel cell power generating system equipped with a reaction gas cooling and humidifying means which can cool and humidify the reaction gas without the use of any heat exchanger.

CONSTITUTION: A solid high-polymer electrolyte type fuel cell 1 consisting of a layer of unit cells where an anode and cathode are arranged in tight attachment on the two surfaces of a solid high-polymer electrolyte film in such a way as pinching it is equipped with a reaction gas cooling and humidifying means 11 which is to cool the reaction gas to a specified level by absorbing the thermal energy possessed excessively by the reaction gas 2F with the evaporative latent heat of the water, humidify the cooled reaction gas with the water vapor

produced, and supply the resultant reaction gas 11F to the anode or cathode.

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CLAIMS

[Claim(s)]

[Claim 1] It consists of a layered product of a single cel which stuck and arranged the anode and the cathode on the both sides on both sides of the solid-state polyelectrolyte film. In what generates electricity by supplying fuel gas to said anode from a fuel refining machine, and supplying an oxidizer to said cathode from an oxidizer supply system Absorb the heat energy which reactant gas, such

as said fuel gas and an oxidizer, has superfluously with the latent heat of vaporization of water, and said reactant gas is cooled to predetermined temperature. And the solid-state polyelectrolyte mold fuel cell generation-of-electrical-energy system characterized by coming to have cooling / humidification means of the reactant gas which humidifies reactant gas with the generated steam and is supplied to a solid-state polyelectrolyte mold fuel cell.

[Claim 2] The solid-state polyelectrolyte mold fuel cell generation-of-electrical-energy system according to claim 1 characterized by coming to allot cooling / humidification means of reactant gas to the supply system of fuel gas.

[Claim 3] The solid-state polyelectrolyte mold fuel cell generation-of-electrical-energy system according to claim 1 characterized by coming to allot cooling / humidification means of reactant gas to the supply system of the reaction air as an oxidizer.

[Claim 4] The solid-state polyelectrolyte mold fuel cell generation-of-electrical-energy system according to claim 1 characterized by being what performs cooling and humidification of reactant gas when cooling / humidification means of reactant gas sprays the pressurized water into reactant gas.

[Claim 5] The solid-state polyelectrolyte mold fuel cell generation-of-electrical-energy system according to claim 1 characterized by coming to have the evaporator which cooling / humidification means of reactant gas becomes from the water retention material of the porosity allotted in the reactant gas path, and the make up water feed zone which supplies water to this evaporator from the exterior.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to cooling and humidification structure of reactant gas which are prepared in the exterior of a solid-state polyelectrolyte mold fuel cell, in order to prevent desiccation of the solid-state polyelectrolyte film especially, a solid-state polyelectrolyte mold fuel cell generation-of-electrical-energy system and.

[0002]

[Description of the Prior Art] The solid-state polyelectrolyte film with which a solid-state polyelectrolyte mold fuel cell has a proton (hydrogen ion) exchange group, The single cel which consists of the anode (fuel electrode) and cathode (oxidizer electrode) which were arranged so that a catalyst bed might stick to the both sides It is constituted as a stack which the separate plate which has a concave as a reactant gas path was made to be placed between both sides, and carried out two or more layer laminating. an anode side -- the hydrogen as a fuel -- by supplying the oxygen or air as an oxidizer to a rich fuel gas and cathode side through said reactant gas path A three-layer interface is formed in the interface of the catalyst bed of two electrodes, and the solid-state polyelectrolyte film. While electrode reaction which the electrode reaction which $H_2 \rightarrow 2H^{++} + 2e$ Becomes in an anode one half $O_2 + 2H^{++} + 2e \rightarrow H_2O$ Turns into in a cathode is performed, hydrogen and oxygen react as a whole and water generates to a cathode side When the generated electron moves through an external circuit, a generation of electrical energy is performed.

[0003] The solid-state polyelectrolyte film has a proton exchange group in a molecule, and it is necessary for the specific resistance of 20 or less ohm-cm to be shown, and to function as a proton conductivity electrolyte in ordinary temperature, to humidify the reactant gas to supply and to maintain the solid-state polyelectrolyte film in the condition of having always got wet, with a solid-state polyelectrolyte mold fuel cell, by carrying out water to a saturation state. As the humidification approach of reactant gas for this, the internal humidifying method or the film humidifying method for passing water and the gas to humidify on both sides of the solid-state polyelectrolyte film, and the external humidifying

method which carries out bubbling of the reactant gas in warm water are learned. [0004] moreover, the hydrogen which reformed natural gas and a methanol with the fuel refining vessel as fuel gas -- the case where the temperature of reformed gas uses 600-700-degreeC and a methanol when a original fuel is natural gas when using rich reformed gas -- 200-400-degreeC 100-degreeC which it becomes and is the operating temperature of a solid-state polyelectrolyte mold fuel cell Since it is high for whether your being Haruka compared with the following, cooling of fuel gas is needed. Furthermore, it is 200-degreeC, even when temperature rises, for example, it is four atmospheric pressures, in case air is pressurized and supplied by the blower or the compressor, when using air as an oxidizing agent. It becomes the elevated temperature of extent and cooling of reaction air is needed too.

[0005] System configuration drawing and drawing 6 which show cooling / humidification method of conventional fuel gas [in / in drawing 5 / a solid-state polyelectrolyte mold fuel cell] are system configuration drawing showing cooling / humidification method of the conventional reaction air. In drawing 5 , it is constituted so that the anode of a fuel cell 1 may be supplied as fuel gas 5F which the heat exchanger 4 which uses cooling water as a cooling medium, and the humidifier 5 by the external humidification method were formed between the anode side of the solid-state polyelectrolyte mold fuel cell 1, and the fuel refining machine 2, and cooled reformed gas 2F near the operating temperature of a fuel cell 1, and were humidified to the saturation state. Moreover, in drawing 6 , it is constituted so that the cathode of a fuel cell 1 may be supplied as reaction air 5A which the heat exchanger 4 which uses cooling water as a cooling medium, and the humidifier 5 by the external humidification method were formed between the cathode side of the solid-state polyelectrolyte mold fuel cell 1, and the compressor 3, and cooled compressed-air 3A near the operating temperature of a fuel cell 1, and was humidified to the saturation state.

[0006]

[Problem(s) to be Solved by the Invention] In order to cool and humidify fuel gas

and reaction air (it combines below and is called reactant gas), while raising the initial cost of a system, there is a problem of causing enlargement of equipment, by the conventional method which grounds the heat exchanger and humidifier of another object. Moreover, since the cooling water for cooling and the heater for humidification are needed, the problem of causing the decline in the thermal efficiency as a system or lifting of operation cost is also generated.

[0007] The object of this invention is to obtain the solid-state polyelectrolyte mold fuel cell generation-of-electrical-energy system equipped with cooling / humidification means of the reactant gas which can cool and humidify reactant gas, without using a heat exchanger.

[0008]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, according to this invention, it consists of a layered product of a single cell which stuck and arranged the anode and the cathode on those both sides on both sides of the solid-state polyelectrolyte film. In what generates electricity by supplying fuel gas to said anode from a fuel refining machine, and supplying an oxidizer to said cathode from an oxidizer supply system Absorb the heat energy which reactant gas, such as said fuel gas and an oxidizer, has superfluously with the latent heat of vaporization of water, and said reactant gas is cooled to predetermined temperature. And it shall come to have cooling / humidification means of the reactant gas which humidifies reactant gas with the generated steam and is supplied to a solid-state polyelectrolyte mold fuel cell.

[0009] Moreover, it crawls and cooling / humidification means of reactant gas considers as both the supply system of fuel gas, the supply system of the reaction air as an oxidizer, and the thing which it comes to allot to a gap or one side. Furthermore, cooling / humidification means of reactant gas decides to be what performs cooling and humidification of reactant gas by spraying the pressurized water into reactant gas. Cooling / humidification means of reactant gas shall consist of an evaporator which consists of water retention material of the porosity allotted in the reactant gas path, and a make up water feed zone

which supplies water from the exterior at this evaporator further again.

[0010]

[Function] Reactant gas is cooled by evaporating water in the configuration of this invention using the heat energy which hot reactant gas has. And by having constituted so that cooling / humidification means of the reactant gas which humidifies reactant gas with the generated steam and is supplied to a solid-state polyelectrolyte mold fuel cell might be established While it can carry out efficiently, without using a heat exchanger for cooling of reactant gas using the exhaust heat of a generation-of-electrical-energy system, and the big latent heat of vaporization of water Since evaporation of water leads to humidification of reactant gas promptly, while an external humidifier also becomes unnecessary and cooling / humidification means of reactant gas with high thermal efficiency is acquired, the function which simplifies the structure of a system is obtained.

[0011] Moreover, both the supply system of fuel gas, the supply system of the reaction air as an oxidizer, and the function to perform cooling and humidification of reactant gas efficiently using the exhaust heat of fuel gas and each reaction air if it constitutes so that it may crawl and may arrange in a gap or one side are obtained in cooling / humidification means of reactant gas. Furthermore, if it constitutes so that cooling and humidification of reactant gas may be performed by spraying the water which pressurized cooling / humidification means of reactant gas into reactant gas, since the fog which was sprayed with high voltage and which carried out grain refining will contact hot reactant gas directly and will evaporate promptly, while reactant gas can be efficiently cooled with the latent heat of vaporization, the function which humidifies reactant gas is obtained.

[0012] If constituted from an evaporator which consists cooling / humidification means of reactant gas of water retention material of the porosity allotted in the reactant gas path further again, and a make up water feed zone which supplies water to this evaporator from the exterior, the function which humidifies reactant gas will be obtained at the same time it cools reactant gas with the latent heat of vaporization of water by making the front face of the large water retention

material of area into a heat exchange side.

[0013]

[Example] Hereafter, this invention is explained based on an example. Drawing 1 is system configuration drawing showing the fuel gas supply system of the fuel cell generation-of-electrical-energy system which becomes the example of this invention, and omits the duplicate explanation by giving the same reference mark to the same component as the conventional technique below. In drawing, cooling / humidification means 11 of fuel gas 2F is established between the anode of the solid-state polyelectrolyte mold fuel cell 1, and the fuel refining machine 2. When 1.13ata(s) and a flow rate were set to 1.0Nm³/min and steam concentration is set [the temperature of fuel gas 2F] to 0.13Nm³/min for 340-degreeC and its pressure, It is 3 per minute 160cm by cooling / humidification means. The temperature of fuel gas is 70-degreeC lower than the operating temperature of a fuel cell 1 by adding water. While being cooled the steam of 0.33Nm³/min is included, since fuel gas 11F of a saturation state can be mostly supplied to the anode of the solid-state polyelectrolyte mold fuel cell 1 While preventing desiccation of the solid-state polyelectrolyte film, the advantage which eliminates the heat exchanger 4 and the external humidifier 5 which were needed with the conventional technique, and can simplify the generation-of-electrical-energy structure of a system is acquired.

[0014] Drawing 2 is system configuration drawing showing the reaction air supply system of the fuel cell generation-of-electrical-energy system which becomes the example from which this invention differs, and cooling / humidification means 11 of reaction air 3A is established between the cathode of the solid-state polyelectrolyte mold fuel cell 1, and a compressor 3. When 4ata(s) and a flow rate were set to 1.0Nm³/min and steam concentration is set [the temperature of reaction air 3A] to 0.02Nm³/min for 213-degreeC and its pressure, It is 3 per minute 74cm by cooling / humidification means. The temperature of reaction air is 75-degreeC lower than the operating temperature of a fuel cell 1 by adding water. While being cooled the steam of 0.113Nm³/min is included, since reaction

air 11A of a saturation state can be mostly supplied to the cathode of the solid-state polyelectrolyte mold fuel cell 1. While preventing desiccation of the solid-state polyelectrolyte film, the advantage which eliminates the heat exchanger 4 and the external humidifier 5 which were needed with the conventional technique, and can simplify the generation-of-electrical-energy structure of a system is acquired.

[0015] Drawing 3 is the sectional view in which, and showing it, and fuel-spray type cooling / humidification means 11 is equipped with the pressure spraying nozzle 12 which sprays the application-of-pressure water 13 which pressurized 10ata extent into the reactant gas path 15. [cooling / humidification means of the reactant gas which becomes the example of this invention] [**] [type] the particle of the water atomized in the reactant gas path -- elevated-temperature fuel gas 2F or reaction air 3A -- it contacts one of reactant gas, and directly, and evaporates promptly, reactant gas is humidified at the same time it cools reactant gas with the latent heat of vaporization, and moisture supplies the anode or cathode of the solid-state polyelectrolyte mold fuel cell 1 as reactant gas of a saturation state mostly. Fuel-spray type cooling / humidification means 11 therefore, by absorbing the heat energy which the reactant gas which it is going to cool has in an excess as the atomized latent heat of vaporization of waterdrop. Since cooling and humidification of reactant gas are performed simultaneously, it is rational and a configuration serves as simple equipment. Since neither cooling water nor the heat source for humidification is needed while eliminating the heat exchanger and humidifier which were needed by the Prior art and being able to simplify the generation-of-electrical-energy structure of a system, the advantage which can contribute also to reduction of the initial cost of a power plant and improvement in thermal efficiency is acquired.

[0016] Drawing 4 is the sectional view in which, and showing it, and evaporation type cooling / humidification means 21 is equipped with the evaporator 22 which consists of water retention material of the porosity allotted in the reactant gas path 15, and the make up water feed zone 23 which supplies water to this

evaporator from the exterior. [cooling / humidification means of the reactant gas which becomes the example from which this invention differs] [**] [type] The function which humidifies reactant gas is obtained at the same time it cools reactant gas with the latent heat of vaporization of water by making the front face of the large water retention material of area into a heat exchange side. In addition, the restoration object of the porosity carbon material which was excellent in thermal resistance as water retention material, and a metal network etc. is suitable, and a cooling / humidification means of reactant gas by which small and a configuration do not need a simple and special heat source can be acquired by arranging these water retention material the shape of the same axle, and in the shape of [mutually parallel] film, and extending evaporation surface area.

[0017]

[Effect of the Invention] As mentioned above, this invention was constituted so that cooling / humidification means of a fuel-spray type or an evaporation type might be formed in the supply system of reactant gas. Consequently, the heat energy which the reactant gas which cooling / humidification means tends to cool has in an excess Absorb as the atomized latent heat of vaporization of waterdrop, and perform cooling and humidification of reactant gas simultaneously, and it is rational and a configuration is equipped with cooling / humidification means of simple reactant gas. While eliminating the heat exchanger needed by the Prior art, a humidifier, and its heat source and being able to reduce the initial cost and operation cost of a generation-of-electrical-energy system, desiccation of the solid-state polyelectrolyte film is prevented and the effectiveness that it is stabilized and the generation-of-electrical-energy engine performance of a solid-state polyelectrolyte mold fuel cell can be maintained is acquired.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] System configuration drawing showing the fuel gas supply system of the fuel cell generation-of-electrical-energy system which becomes the example of this invention

[Drawing 2] System configuration drawing showing the reaction air supply system of the fuel cell generation-of-electrical-energy system which becomes the example from which this invention differs

[Drawing 3] The sectional view in which, and showing it [cooling / humidification means of the reactant gas which becomes the example of this invention] [**] [type]

[Drawing 4] The sectional view in which, and showing it [cooling / humidification means of the reactant gas which becomes the example from which this invention differs] [**] [type]

[Drawing 5] System configuration drawing showing cooling / humidification method of the conventional fuel gas in a solid-state polyelectrolyte mold fuel cell

[Drawing 6] System configuration drawing showing cooling / humidification method of the conventional reaction air

[Description of Notations]

1 Solid-state Polyelectrolyte Mold Fuel Cell

2 Fuel Refining Machine

2F Fuel gas (un-humidifying [an elevated temperature,])

3 Compressor

3A Reaction air (un-humidifying [an elevated temperature,])

4 Heat Exchanger

5 Humidifier

11 Fuel-Spray Type Cooling / Humidification Means

11A Reaction air (finishing [cooling and humidification])

11F Fuel gas (finishing [cooling and humidification])

12 Pressure Spraying Nozzle

13 Application-of-Pressure Water

14 Atomized Water

15 Reactant Gas Path

21 Evaporation Type Cooling / Humidification Means

22 Evaporator (Porosity Water Retention Material)

23 Make Up Water Feed Zone

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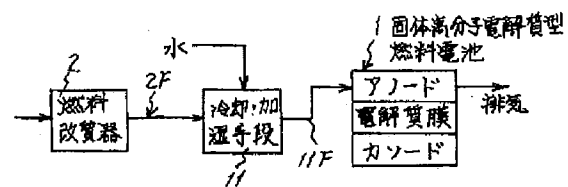
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(54)【発明の名称】 固体高分子電解質型燃料電池発電システム

(57)【要約】

【目的】熱交換器を用いずに反応ガスを冷却、かつ加湿できる反応ガスの冷却・加湿手段を備えた固体高分子電解質型燃料電池発電システムを得る。

【構成】固体高分子電解質膜を挟んでその両面にアノードおよびカソードを密着して配した単セルの積層体からなる固体高分子電解質型燃料電池1が、反応ガス2Fが過剰に持つ熱エネルギーを水の蒸発潜熱により吸収して反応ガスを所定の温度に冷却し、かつ生成した水蒸気により加湿した反応ガス11Fとしてアノードまたはカソードに供給する反応ガスの冷却・加湿手段11を備える。



【特許請求の範囲】

【請求項1】 固体高分子電解質膜を挟んでその両面にアノードおよびカソードを密着して配した単セルの積層体からなり、前記アノードに燃料改質器から燃料ガスを、前記カソードに酸化剤供給系から酸化剤を供給することにより発電を行うものにおいて、前記燃料ガス、酸化剤等の反応ガスが過剰に持つ熱エネルギーを水の蒸発潜熱により吸収して前記反応ガスを所定の温度に冷却し、かつ生成した水蒸気により反応ガスを加湿して固体高分子電解質型燃料電池に供給する反応ガスの冷却・加湿手段を備えてなることを特徴とする固体高分子電解質型燃料電池発電システム。

【請求項2】 反応ガスの冷却・加湿手段が燃料ガスの供給系に配されてなることを特徴とする請求項1記載の固体高分子電解質型燃料電池発電システム。

【請求項3】 反応ガスの冷却・加湿手段が酸化剤としての反応空気の供給系に配されてなることを特徴とする請求項1記載の固体高分子電解質型燃料電池発電システム。

【請求項4】 反応ガスの冷却・加湿手段が、加圧した水を反応ガス中に噴霧することにより、反応ガスの冷却および加湿を行うものであることを特徴とする請求項1記載の固体高分子電解質型燃料電池発電システム。

【請求項5】 反応ガスの冷却・加湿手段が、反応ガス通路内に配された多孔質の保水材からなる蒸発部と、この蒸発部に外部から水を補給する補給水供給部とを備えてなることを特徴とする請求項1記載の固体高分子電解質型燃料電池発電システム。

【発明の詳細な説明】

【0001】

【産業上の利用分野】 この発明は、固体高分子電解質型燃料電池発電システム、ことに固体高分子電解質膜の乾燥を防ぐために、固体高分子電解質型燃料電池の外部に設けられる反応ガスの冷却および加湿構造に関する。

【0002】

【従来の技術】 固体高分子電解質型燃料電池は、プロトン（水素イオン）交換基を有する固体高分子電解質膜と、その両面に触媒層が密着するよう配されたアノード（燃料電極）およびカソード（酸化剤電極）とからなる単セルを、両面に反応ガス通路としての凹溝を有するセパレート板を介在させて複数層積層したスタックとして構成され、アノード側に燃料としての水素リッチな燃料ガス、カソード側に酸化剤としての酸素または空気を前記反応ガス通路を介して供給することにより、両電極の触媒層と固体高分子電解質膜との界面に三層界面が形成され、アノードでは $\text{H}_2 \rightarrow 2\text{H}^+ + 2\text{e}^-$ なる電極反応が、カソードでは $\frac{1}{2}\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2\text{O}$ なる電極反応が行われ、全体として水素と酸素が反応してカソード側に水が生成するとともに、生成した電子が外部回路を通過して移動することにより発電が行われる。

【0003】 固体高分子電解質膜は分子中にプロトン交換基を持ち、飽和状態に含水させることにより常温で $20\Omega\text{-cm}$ 以下の比抵抗を示し、プロトン導電性電解質として機能するものであり、固体高分子電解質型燃料電池では供給する反応ガスを加湿して固体高分子電解質膜を常に濡れた状態に維持する必要がある。このための反応ガスの加湿方法としては、固体高分子電解質膜の両側に水と加湿する気体とを流す内部加湿法または膜加湿法と、温湯中で反応ガスをバブリングする外部加湿法とが知られている。

【0004】 また、燃料ガスとして天然ガスやメタノールを燃料改質器で改質した水素リッチな改質ガスを使用する場合、改質ガスの温度が原燃料が天然ガスである場合 $600\sim 700^\circ\text{C}$ 、メタノールを使用した場合でも $200\sim 400^\circ\text{C}$ となり、固体高分子電解質型燃料電池の運転温度である 100°C 以下に比べて遙かに高いため、燃料ガスの冷却が必要になる。さらに、酸化剤として空気を使用する場合、空気をブロウまたはコンプレッサで加圧して供給する際温度が上昇し、例えば4気圧の場合でも 200°C 程度の高温になり、やはり反応空気の冷却が必要になる。

【0005】 図5は固体高分子電解質型燃料電池における従来の燃料ガスの冷却・加湿方式を示すシステム構成図、図6は従来の反応空気の冷却・加湿方式を示すシステム構成図である。図5において、固体高分子電解質型燃料電池1のアノード側と燃料改質器2との間には、冷却水を冷却媒体とする熱交換器4および外部加湿方式による加湿器5が設けられ、改質ガス2Fを燃料電池1の運転温度近くに冷却し、かつ飽和状態に加湿した燃料ガス5Fとして燃料電池1のアノードに供給するよう構成される。また、図6において、固体高分子電解質型燃料電池1のカソード側とコンプレッサ3との間には、冷却水を冷却媒体とする熱交換器4および外部加湿方式による加湿器5が設けられ、圧縮空気3Aを燃料電池1の運転温度近くに冷却し、かつ飽和状態に加湿した反応空気5Aとして燃料電池1のカソードに供給するよう構成される。

【0006】

【発明が解決しようとする課題】 燃料ガスおよび反応空気（以下併せて反応ガスとよぶ）を冷却・加湿するために、別体の熱交換器および加湿器を接地する従来の方式では、システムの初期コストを上昇させるとともに、装置の大型化を招くという問題がある。また、冷却のための冷却水や加湿のためのヒーターを必要とするために、システムとしての熱効率の低下、あるいは運転コストの上昇を招くという問題も発生する。

【0007】 この発明の目的は、熱交換器を用いずに反応ガスを冷却、かつ加湿できる反応ガスの冷却・加湿手段を備えた固体高分子電解質型燃料電池発電システムを得ることにある。

【0008】

【課題を解決するための手段】上記課題を解決するために、この発明によれば、固体高分子電解質膜を挟んでその両面にアノードおよびカソードを密着して配した単セルの積層体からなり、前記アノードに燃料改質器から燃料ガスを、前記カソードに酸化剤供給系から酸化剤を供給することにより発電を行うものにおいて、前記燃料ガス、酸化剤等の反応ガスが過剰に持つ熱エネルギーを水の蒸発潜熱により吸収して前記反応ガスを所定の温度に冷却し、かつ生成した水蒸気により反応ガスを加湿して固体高分子電解質型燃料電池に供給する反応ガスの冷却・加湿手段を備えてなるものとする。

【0009】また、反応ガスの冷却・加湿手段が燃料ガスの供給系、酸化剤としての反応空気の供給系の両方、またはいずれか一方に配されてなるものとする。さらに、反応ガスの冷却・加湿手段が、加圧した水を反応ガス中に噴霧することにより、反応ガスの冷却および加湿を行うものであることとする。さらにまた、反応ガスの冷却・加湿手段が、反応ガス通路内に配された多孔質の保水材からなる蒸発部と、この蒸発部に外部から水を補給する補給水供給部とからなるものとする。

【0010】

【作用】この発明の構成において、高温の反応ガスが持つ熱エネルギーを利用して水を蒸発させることにより反応ガスを冷却し、かつ生成した水蒸気により反応ガスを加湿して固体高分子電解質型燃料電池に供給する反応ガスの冷却・加湿手段を設けるよう構成したことにより、発電システムの排熱と、水の大きな蒸発潜熱とを利用して反応ガスの冷却を熱交換器を用いることなく効率よく行えると同時に、水の蒸発が直ちに反応ガスの加湿につながるので外部加湿器も不要になり、熱効率の高い反応ガスの冷却・加湿手段が得られるとともに、システムの構成を簡素化する機能が得られる。

【0011】また、反応ガスの冷却・加湿手段を燃料ガスの供給系、酸化剤としての反応空気の供給系の両方、またはいずれか一方に配設するよう構成すれば、燃料ガスおよび反応空気それぞれの排熱を利用して反応ガスの冷却および加湿を効率よく行う機能が得られる。さらに、反応ガスの冷却・加湿手段を、加圧した水を反応ガス中に噴霧することにより、反応ガスの冷却および加湿を行うよう構成すれば、高圧で噴霧した細粒化した霧が高温の反応ガスに直接接触して直ちに蒸発するので、その蒸発潜熱により反応ガスを効率よく冷却できると同時に反応ガスを加湿する機能が得られる。

【0012】さらにまた、反応ガスの冷却・加湿手段を、反応ガス通路内に配された多孔質の保水材からなる蒸発部と、この蒸発部に外部から水を補給する補給水供給部とで構成すれば、面積の大きい保水材の表面を熱交換面として水の蒸発潜熱により反応ガスを冷却すると同時に反応ガスを加湿する機能が得られる。

【0013】

【実施例】以下、この発明を実施例に基づいて説明する。図1はこの発明の実施例になる燃料電池発電システムの燃料ガス供給系を示すシステム構成図であり、以下従来技術と同じ構成部分には同一参照符号を付すことにより、重複した説明を省略する。図において、固体高分子電解質型燃料電池1のアノードと燃料改質器2の間には、燃料ガス2Fの冷却・加湿手段11が設けられる。燃料ガス2Fの温度を 340°C 、その圧力を 1.13ata 、流量を $1.0\text{Nm}^3/\text{min}$ 、水蒸気濃度を $0.13\text{Nm}^3/\text{min}$ とした場合、冷却・加湿手段により毎分 160cm^3 の水を添加することで燃料ガスの温度は燃料電池1の運転温度より低い 70°C に冷却されるとともに、 $0.33\text{Nm}^3/\text{min}$ の水蒸気を含むほぼ飽和状態の燃料ガス11Fを固体高分子電解質型燃料電池1のアノードに供給できるので、固体高分子電解質膜の乾燥を防ぐとともに、従来技術で必要とした熱交換器4および外部加湿器5を排除して発電システムの構成を簡素化できる利点が得られる。

【0014】図2はこの発明の異なる実施例になる燃料電池発電システムの反応空気供給系を示すシステム構成図であり、固体高分子電解質型燃料電池1のカソードとコンプレッサ3の間には、反応空気3Aの冷却・加湿手段11が設けられる。反応空気3Aの温度を 213°C 、その圧力を 4ata 、流量を $1.0\text{Nm}^3/\text{min}$ 、水蒸気濃度を $0.02\text{Nm}^3/\text{min}$ とした場合、冷却・加湿手段により毎分 74cm^3 の水を添加することで反応空気の温度は燃料電池1の運転温度より低い 75°C に冷却されるとともに、 $0.113\text{Nm}^3/\text{min}$ の水蒸気を含むほぼ飽和状態の反応空気11Aを固体高分子電解質型燃料電池1のカソードに供給できるので、固体高分子電解質膜の乾燥を防ぐとともに、従来技術で必要とした熱交換器4および外部加湿器5を排除して発電システムの構成を簡素化できる利点が得られる。

【0015】図3はこの発明の実施例になる反応ガスの冷却・加湿手段を模式化して示す断面図であり、噴霧式冷却・加湿手段11は 10ata 程度に加圧した加圧水13を反応ガス通路15内に噴霧する圧力噴霧ノズル12を備える。反応ガス通路内で霧化した水の粒子は、高温燃料ガス2Fまたは反応空気3Aいずれかの反応ガスと直接接触して直ちに蒸発し、その蒸発潜熱により反応ガスを冷却すると同時に反応ガスを加湿し、水分がほぼ飽和状態の反応ガスとして固体高分子電解質型燃料電池1のアノードまたはカソードに供給する。したがって、噴霧式冷却・加湿手段11は、冷却しようとする反応ガスが余分に持つ熱エネルギーを、霧化した水滴の蒸発潜熱として吸収することにより、反応ガスの冷却および加湿を同時に行う合理的で構成が簡素装置となるので、従来の技術で必要とした熱交換器や加湿器を排除して発電システムの構成を簡素化できるとともに、冷却水や加湿用

の熱源を必要としないので、発電装置の初期コストの低減および熱効率の向上にも貢献できる利点が得られる。

【0016】図4はこの発明の異なる実施例になる反応ガスの冷却・加湿手段を模式化して示す断面図であり、蒸発式冷却・加湿手段21は、反応ガス通路15内に配された多孔質の保水材からなる蒸発部22と、この蒸発部に外部から水を補給する補給水供給部23とを備える。面積の大きい保水材の表面を熱交換面として水の蒸発潜熱により反応ガスを冷却すると同時に反応ガスを加湿する機能が得られる。なお、保水材としては耐熱性に優れた多孔質カーボン材、金属網の充填体等が適しており、これらの保水材を同軸状あるいは互いに平行した膜状に配置して蒸発表面積を拡張することにより、小型かつ構成が簡素で特別な熱源を必要としない反応ガスの冷却・加湿手段を得ることができる。

【0017】

【発明の効果】この発明は前述のように、反応ガスの供給系に噴霧式または蒸発式の冷却・加湿手段を設けるよう構成した。その結果、冷却・加湿手段が冷却しようとする反応ガスが余分に持つ熱エネルギーを、霧化した水滴の蒸発潜熱として吸収して反応ガスの冷却および加湿を同時に行う合理的で構成が簡素な反応ガスの冷却・加湿手段を備え、従来の技術で必要とした熱交換器や加湿器、およびその熱源を排除して発電システムの初期コストおよび運転コストを低減できるとともに、固体高分子電解質膜の乾燥を防止して固体高分子電解質型燃料電池の発電性能を安定して維持できる効果が得られる。

【図面の簡単な説明】

【図1】この発明の実施例になる燃料電池発電システム

の燃料ガス供給系を示すシステム構成図

【図2】この発明の異なる実施例になる燃料電池発電システムの反応空気供給系を示すシステム構成図

【図3】この発明の実施例になる反応ガスの冷却・加湿手段を模式化して示す断面図

【図4】この発明の異なる実施例になる反応ガスの冷却・加湿手段を模式化して示す断面図

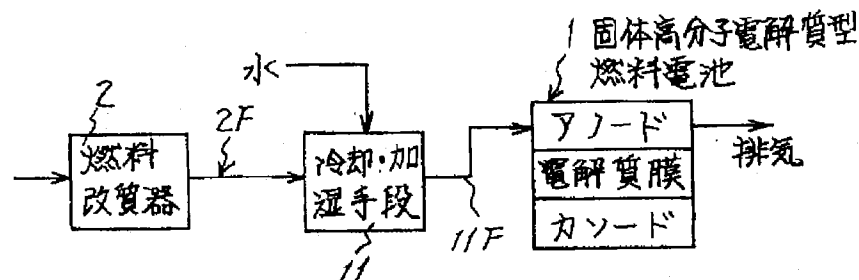
【図5】固体高分子電解質型燃料電池における従来の燃料ガスの冷却・加湿方式を示すシステム構成図

【図6】従来の反応空気の冷却・加湿方式を示すシステム構成図

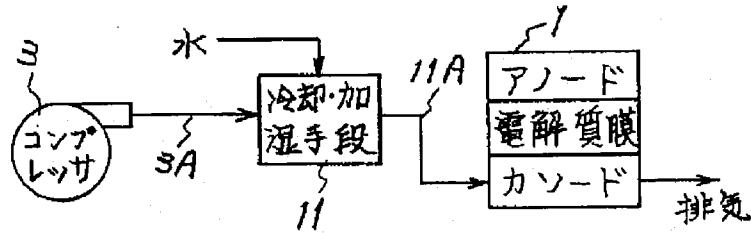
【符号の説明】

- 1 固体高分子電解質型燃料電池
- 2 燃料改質器
- 2F 燃料ガス（高温、未加湿）
- 3 コンプレッサ
- 3A 反応空気（高温、未加湿）
- 4 熱交換器
- 5 加湿器
- 11 噴霧式冷却・加湿手段
- 11A 反応空気（冷却、加湿済）
- 11F 燃料ガス（冷却、加湿済）
- 12 圧力噴霧ノズル
- 13 加圧水
- 14 霧化した水
- 15 反応ガス通路
- 21 蒸発式冷却・加湿手段
- 22 蒸発部（多孔質保水材）
- 23 補給水供給部

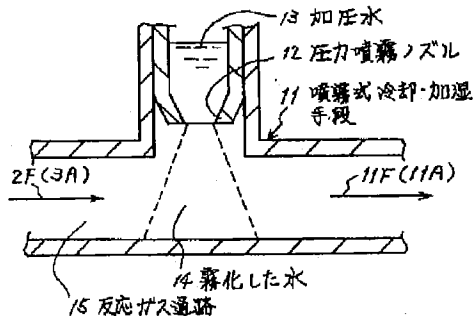
【図1】



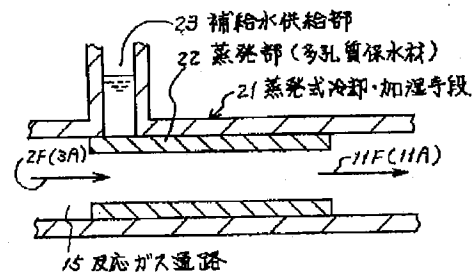
【図2】



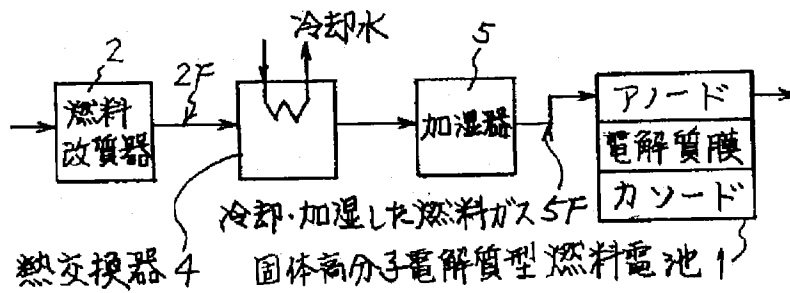
【図3】



【図4】



【図5】



【図6】

